

DEVELOPMENT OF WORKSHEET BASED ON INQUIRY WITH SAINTIFIC APPROACH TO TRAIN STUDENT CRITICAL THINKING ON THERMOCHEMISTRY MATERIAL

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Abstrak

This study aims to train the students' critical thinking based on inquiry with scientific approach on thermochemistry material. Assessment on worksheet is based on theoretical and empirical assessment, in which theoretical value according to Permendikbud is material compatibility, presentation, language, graph. This study uses type of research of development method with Research & Development (R & D) model on a limited trial. This study is a quantitative method with Pretest Posttest Design. This study was conducted in SMAN 2 KOTA MOJOKERTO. Sources of data in this study are the review, validation and students' response, pretest and posttest question sheets based on inquiry with scientific approach that tested on 16 students. The study was conducted three times. Percentage of validity on worksheet with presentation of each criterion are between 75% - 100%. Critical thinking skills are motivation, considering the credibility of information resources, inducing and considering induced results, observing and considering observations, categorized in very good order (90% - 80%), very good (100%), very good (86.67%-100%), and very good (100%). Students' response on the developed of worksheet are reviewed theoretically and empirically from the content/material, linguistic presentation, and graph criteria, show a positive response in which the percentage obtained for each criterion are between 87.50%-100%, thus categorized as feasible source of learning .

Keywords: Critical Thinking, Inquiry, Scientific

INTRODUCTION

Chemistry as a product and process, it is suitable to be taught by using scientific approach, scientific approach has a close relationship with chemistry science learning because this learning approach emphasizes the students' activity in learning, and provides opportunities for students to build concepts in knowledge independently, familiarize students in mocking, dealing with, and solving the problems found. Permendikbud No. 58 in 2014 improving the Mindset, the 2013 curriculum is developed with the following improvements of mindset: (4) Reinforcing active-finding learning (active-finding learning is strengthened with scientific learning approach); (9) Reinforcing of critical learning pattern[1].

In the 2013/2014 academic year, Indonesia officially uses the 2013 curriculum. The 2013 curriculum aims to direct productive resources into competent and skilled human resources, and adapt educational developments at the International level, since 1999 showing the achievements of Indonesian children are not encouraging in some times of reports issued by TIMSS and PISA (permendikbud number 70, 2013) [2].

Understanding concepts in learning is very important because it can affect to attitudes, decisions, and ways to solve problems. In fact

learners have not been able to overcome the problem in the learning process with the concept. On that basis, the concepts in the matter of rate reaction must be confirmed by proving in a practical experiment. From this practical activity students can be invited to think critically because students are required to find the concept based on observations made[3].

Nurul (Johari Marjan, 2013) mentions a scientific-based learning is a learning that uses a scientific approach and inquiry, where students play directly both individually and in groups to explore concepts and principles during learning activities, while the teacher's task is to direct the learning process undertaken by students and provide corrections to the concepts and principles that students get[4].

Sulistiningsih (2012) in her research reveals that teachers are lacking in training critical thinking skills. Reinforced with the results of field studies, the results obtained students' critical thinking skills are still less. As many as 91,7% of students have not been able to propose problem formulation 75% students have not been able to formulate hypothesis; whereas 91,7% students have not been able to determine the variable. As many as 66, 7% of students have been able to answer questions correctly, and 66.7% of students have not been able to determine the right conclusions[5].

METHOD

Research methodology used is research and development method or Research and Development (R&D). According Sugiyono (2011) Research and Development / R & D is a research method used to produce a particular product, test the effectiveness of the product. Stages in research and development methods are: 1) Preliminary study phase, 2) Development study stage, 3) Evaluation phase. However, this study is only limited to the development study stage, for the evaluation phase is not done[6].

Sources of data obtained from the review, validation and limited trials. The limited trial phase of the developed worksheet was carried out to 16 high school class XI students included in the small group evaluation. According to Sadiman (2010) the media needs to be tried to 10-20 students who can represent the target population, this stage is included in small group evaluation[7].

Instruments used in this study include a review sheet, validation sheet, student response questionnaire, and critical thinking skills.

The data of this study were analyzed descriptively ie about the suggestion or input based on the result of study data by the chemistry lecturer for the improvement of the developed worksheet. The study is based on the content / material, presentation, language and layout graphic components of the developed worksheet.

Data of worksheet validation result developed, analyzed by using descriptive method. This analysis is performed on each component present in the validation sheet. The percentage of this validation result data is obtained based on the likert scale as in the following table.

Table 1 Likert Scale

Score	Criteria
5	Very Good
4	Good
3	Enough
2	Less
1	Bad

[7]

The value obtained is calculated by the percentage of eligibility using formula (1):

$$K = \frac{F}{N \times I \times R} \times 100 \%$$

- K = percentage of assessment
F = number of respondents' answers
N = highest score in questionnaire
I = number of questions in the questionnaire
R = number of respondents

Then, the percentage obtained by interpreted using a Likert scale criteria in Table 2:

Table 2 Likert Scale Criteria

Percentage	Category
0% -2%	Very bad
21% -40%	Bad
41% -60%	Medium
61% -80%	Good
81% -100%	Very Good

[8]

Based on the criteria of interpretation score, the developed worksheet is said to meet the criteria of the content / material, presentation, language and layout graphic if the percentage reaches $\geq 61\%$ students so feasible to be used in the learning process.

Questionnaire responses given after the limited trial and analyzed descriptively. The percentage of student questionnaire data was obtained based on calculation of Guttman score scale in the following Table 3 below:

Table 3 Guttman Scale

Assessment	Score
Yes	1
No	0

[8]

The obtained data is calculated to get the percentage of student response result by using formula (2):

$$P(\%) = \frac{\text{amount of yes or no answer}}{\text{amount of respondents}} \times 100\%$$

[8]

Determine feasibility of student response was seen from the practically that was interpreted into the criteria in Table 4 below:

Table 4 Criteria Interpretation Score of Student Response Selection Results

Percentage(%)	Criteria
0-20	Very Less practical
21-40	Less practical
41-60	Quite practical
61-80	Practical
81-100	Very Practical

[8]

Based on that criteria, the practicality of the developed worksheet is considered feasible as obtaining a percentage of $\geq 61\%$.

Final Test

The final test was used to assess students conceptual understanding and students' critical thinking skills. Assessment of students' critical thinking skills and understanding of student concepts is based on the results of train 12 critical thinking skills in the essay form. Data analysis of conceptual understanding assessment result and

students' critical thinking skill is done on the final test score. The final test is adapted with basic competencies that have been formulated by the syllabus 2013 curriculum. The final test that has been given to the students will then be analyzed until the individual can complete whether it has fulfilled the KKM (KKM 70) or still have not complete yet (Kemendikbud, 2013). The final test is used to assess basic skills by knowing the students pre test and post test as well as students' critical thinking skills. Analysis data of student's learning outcomes is done by find out the pretest and post test results individually that have been passed by score ≥ 70 . The score of student learning outcomes analyzed by the following formula (3) below:

$$\text{Score of learning results} = \frac{\text{scores obtained}}{\text{maximum scores}} \times 100$$

Data analysis of students' critical thinking skill is done on 12 critical skill questions in the essay form, which contains critical thinking indicator. This analysis is a descriptive analysis based on critical thinking assessment aspect. Indicator of critical thinking skills that can be made as criterion with scoring 1 to 5. Score 1 is the lowest while score 5 is the highest score. The criterion is shown in Appendix 6. Each question is analyzed to find out the students' critical thinking skills in each question. Each question will be calculated on its average in each indicator. The calculation of the average percentage of each indicator. The acquired scores data were analyzed by using the formula (6):

$$\frac{\text{Percentage gained}}{\text{Total student score in a single indicator}} \times \frac{\text{the maximum number of values in a single indicator}}{100\%}$$

The percentage obtained is interpreted into the criteria seen in Table 5

Table 5 Criteria Interpretation of Critical Thinking Skills Question

Percentage (%)	Criteria
0-20	Very less effective
21-40	Less effective
41-60	Effective enough
61-80	Effective
81-100	Very effective

[8]

If the percentage obtained in each question reached $\geq 61\%$ then the students' critical thinking on the indicator is categorized effective. worksheet can be said to train critical thinking skills are categorized effective.

RESULTS AND DISCUSSION

Validity

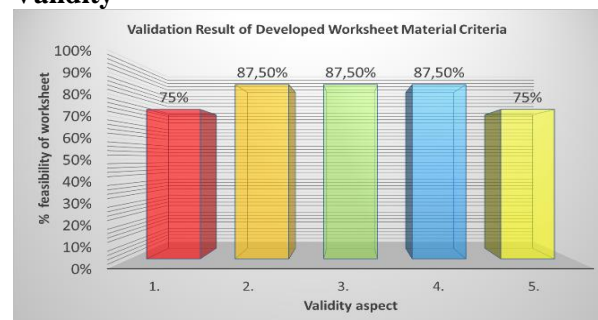


Diagram 1 Validation Result of Developed Worksheet Material Criteria

Validation results data on the criteria of material should be able to maintain the truth and accuracy of the material, data and concept updates, and can support the achievement of national education goals reach the value of 75% indicating passing criteria. The criteria of use correctly theoretical and empirical material resources that achieve the value of 87.5% show very eligible criteria. The criteria encourage independence and innovation to achieve the value of 87.5% which indicates very eligible criteria. The criteria is able to motivate to develop itself reaches the value of 87.5% show criteria very eligible. On the aspect of maintaining the unity and unit of the nation by accommodating diversity, the nature of mutual cooperation, and appreciating various differences reaches 75% show to eligible criteria.

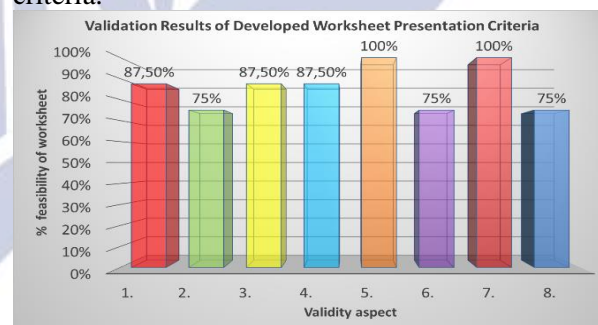


Diagram 2 Validation Results of Developed Worksheet Presentation Criteria

The three aspects that have the lowest value are still included in the criteria, where the indicators to 2, 6 and 8.

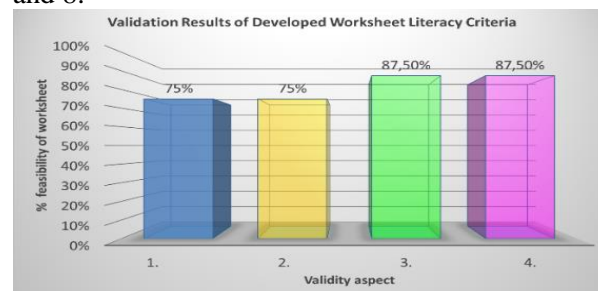


Diagram 3 Validation Results of Developed Worksheet Literacy Criteria

It is known that the two components of the literacy criteria get a very feasible value percentage where the language and title are feasible.

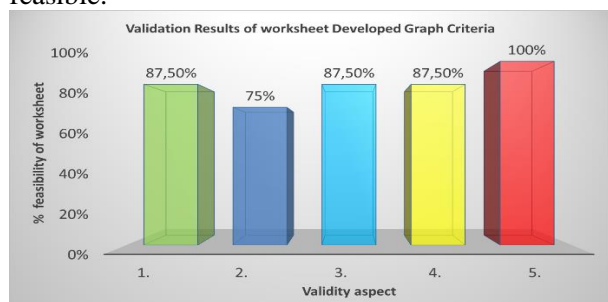


Diagram 4 Validation Results of worksheet Developed Graph Criteria

Included in the criterion of graph value of perfect percentage where the illustrations is used are able to clarify the message delivered.

Student Understanding Outcomes

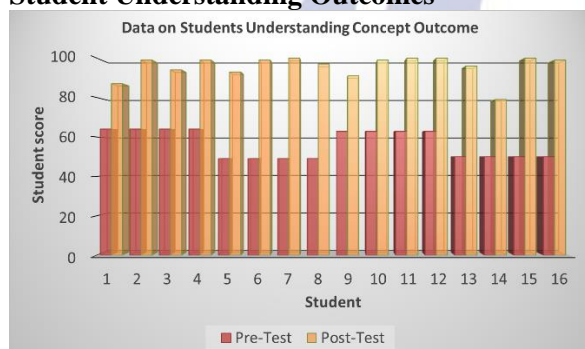


Diagram 5 Data on Students Understanding Concept Outcome

All students when doing pretest, the student value not meet the criteria of KKM whereas after the exercise of critical thinking, the value of students meet the KKM. So, The worksheet was trained for student is successful. Absolutly the feasibility developed worksheet is categorized as feasible to be used as a learning source with presentation of each criterion between 75% - 100%. Students' responses in developed worksheet are show a positive response which the percentage obtained for each criterion between 87.50% - 100%, so categorized feasible as learning resources.

Train to critical thinking for student

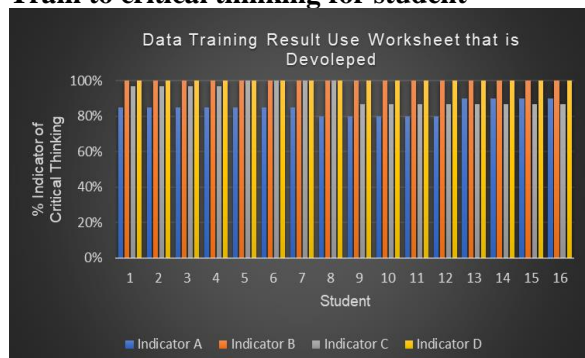


Diagram 6 Data on Results of Student Critical Thinking Skills

In the focusing the question indicator there are 4 question where only one question dominates the less value on the 1a question where the question of identifying problems that occur in the phenomenon, this is according to Piaget basically every individual since childhood already has ability to construct own knowledge. The knowledge constructed by the child as the subject, will be a meaningful knowledge while the knowledge gained only through the notification process will not become meaningful knowledge. While the other question on average has a value that meets the criteria[9].

Student Response Questionnaire

Table 10 Results of Student Response Questionnaire

No.	Questionnaire aspect	Percentage of Student Response (%)	Criteria	
			feasible	Very feasible
1	CRITERIA OF MATERIAL	93,75 %		√
	a.Are the materials in the worksheet easy to understand?			
	b. Is the question in the worksheet in accordance with the material being taught?	100%		√
	c.Is the question in the worksheet easy to understand?	87,50 %		√
	d. Does the laboratory activity in the worksheet fit the material?	100 %		√
	e. Is using this worksheet you can answer the question of the phenomenon with critical thinking?	93,75 %		√
	f. Is the question coherent in accordance with the scientific approach allows you to settle the phenomenon in the worksheet?	93,75 %		√
2	CRITERIA OF PRESENTATION	93,75 %		√

No.	Questionnaire aspect	Percentage of Student Response (%)	Criteria	
			feasible	Very feasible
	a. Do the presentation of this worksheet raise your motivation in eksoterm-enderm material?			
	b. Are the illustrations and pictures in the worksheet can help you understand the material?	93,75 %		√
	c. Is the presentation of worksheet interesting?	100 %		√
	d. Do worksheet presentation be able encourage you to active in learning activities?	100 %		√
	e. Do the presentation of worksheet raise curiosity so that you are motivated to ask questions?	100 %		√
	f. Can worksheet representation help you work in groups?	87,50%		√
	g. Are the phenomena, essay, or explanations in the worksheet easy to be understood?	93,75 %		√
3.	CRITERIA OF LITERACY	93,75 %		√
	a. Does worksheet writing use terms that you can easily understand?			
	b. Is the language used in the worksheet short and clear?	93,75 %		√
4.	CRITERIA OF GRAPH	93,75 %		√
	a. Do the illustrations and images in this			
	worksheet support?			
	b. Do the type of letter and the size of the posts in this worksheet make you comfortable reading worksheet?	100 %		√

For all of the indicators filled, the whole meets the criteria above 65%. There is a perfect score of 100% percentage on "the compability indicator of worksheet with material be taught", "laboratory activity is compatible with material be taught", "presentation of worksheet is interesting", "presentation of worksheet can encourage you to be active in learning activities", "the presentation of worksheet raises curiosity so you are motivated to ask", "and the type of letters and the size of the posts in this worksheet make students comfortable to reading worksheet". The lowest score is 87.50% on the "question in the worksheet are easy to understand" and "worksheet can help you work in groups", caused by "question in the worksheet is easy to be understood" in because for each student has different abilities depending on how often they read and according to Costa says that there is no way to clarify thinking skills, but he suggests from various writings about thinking skills into four levels namely where the first level is discrete thinking skills, second level is strategic thinking skill, third level is creative thinking skill, while the fourth thinking skills is cognitive inspiration [5]; if the student be able to get through first level the worksheet feel difficult for them, the cause is "worksheet can help you work in groups" because in some students who have been able to work independently are asked to help friends who do not understand yet the material by working in laboratorium as well as analyzing together.

CLOSURE

Conclusion

1. Feasibility developed worksheet is reviewed theoretically and empirically on content / material, literacy, presentation, and layout graph criteria categorized as feasible to be used as a learning source with presentation of each criterion between 75% - 100%.
2. Critical thinking skills focusing on questions, considering the credibility of information

sources, inducing and considering induced results, observing and considering observation results, categorized in very good order (90%-80%), very good (100%), very good (86,67% - 100%), and very good (100%).

3. Students' responses in developed worksheet are reviewed theoretically and empirically from content / material, literacy, presentation, and graph criteria show a positive response which the percentage obtained for each criterion between 87.50% - 100%, so categorized feasible as learning resources.

Suggestion

Suggestions for further researchers and teachers who will use the worksheet developed in the learning process that the phase researcher done are limited to test phase, so it needs to be done further research for worksheet can be developed better.

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